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ABSTRACT

This curriculum guide contains materials for use in implementing four levels of a course in electrical occupations that is designed for students in grades 9-12. Presented first are concept lists, instructional planning (learning activity) sheets, and project sheets for use in teaching the third and fourth levels of the course. Level V instructional units include the following topics: electrical construction and troubleshooting, power supplies, solid state devices, amplification, and digital fundamentals. Provided for use in the sixth level of the course are instructional units dealing with AM-FM radios, audio systems, television systems, digital systems and microprocessors, solid state devices, and appliance repair. Appendixes to the guide contain safety and project guide sheets, a bibliography, a circuit trainer exploration sheet, tool requirement lists, a glossary of applied technology, and a skills card. (MN)

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# ELECTRICITY - ELECTRONICS

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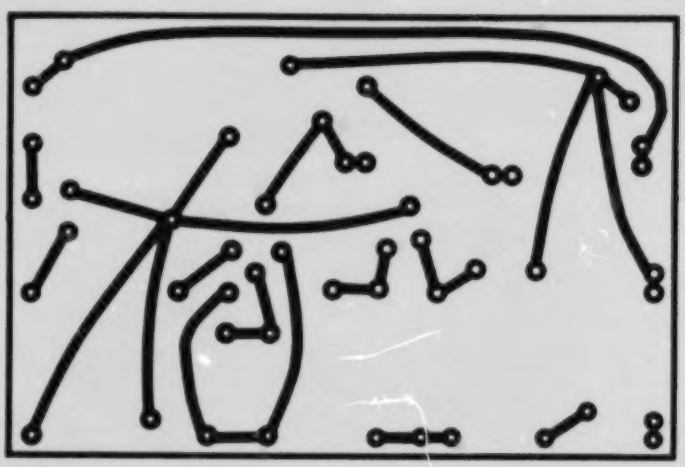
# Electrical Occupations Curriculum Guide Levels 3 - 6



CG017925

PORTLAND PUBLIC SCHOOLS

# ELECTRICAL OCCUPATIONS CURRICULUM GUIDE

## LEVELS 3 through 6

DEVELOP AND IMPLEMENT MODEL
ELECTRICAL CLUSTER PROGRAM

GRANT NO. 26-001-995
VEC. NO. 20-462

PROJECT DIRECTOR: CAROL MATARAZZO

PORTLAND SCHOOL DISTRICT 1J
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OCTOBER, 1983

OREGON DEPARTMENT OF EDUCATION
CAREER AND VOCATIONAL EDUCATION DIVISION

# SECTION II

# LEVELS 3 - 6

SECTION II
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These curriculum units will be field tested at Benson High School during the 1983-84 school year. Revision and refinement of the units will take place during the summer of 1984.

## LEVEL III

### Concept List

1. How Electricity is Produced
2. Transportation of Energy Using Electricity
3. Factors of Electricity
4. Color Code
5. Ohm's Law
6. Meters
7. Basic Resistive Circuits
8. Magnetism
9. Introduction to AC Power
10. Working Safely with Electricity
11. Motor Types
12. Transformers
13. Soldering and Wire Splices
14. Switches
15. Switching Logic
16. House Wiring
17. How to Read the Electric Kilowatt Hour Meter
18. Lighting Systems
19. Projects
    a. Continuity Tester
    b. 12v Step Down Transformer
    c. DC Motor

INSTRUCTIONAL PLANNING SHEET

LEVEL III

CONCEPT

How Electricity is Produced

DEPTH OF INSTRUCTION

2

## LEARNING ACTIVITIES

The student will be able to:

Learn how electricity is produced through various means: chemical
mechanical
thermal
photo
piezo

Complete assignments in: Electricity and Electrinics Basic
Steinberg/Ford
units 6 - 9

The instructor will demonstrate the production of electricity through the various means listed above.

INSTRUCTIONAL PLANNING SHEET

LEVEL III

CONCEPT

Transportation of Energy Using Electricity

DEPTH OF INSTRUCTION

2

## LEARNING ACTIVITIES

The student will be able to:

Be able to identify and know the uses of conductors and insulators.

Complete assignments in: Electricity and Electronics Basic
Steinberg/Ford
units 13, 16

The instructor will do a demonstration showing different conductor and insulator sizes.

INSTRUCTIONAL PLANNING SHEET

LEVEL III

CONCEPT

Factors of Electricity

DEPTH OF INSTRUCTION

3

LEARNING ACTIVITIES

The student will be able to:

Define the measurements of: voltage
current
resistance
power

Complete assignments in: Electricity and Electronics Basic
Steinberg/Ford
units 10 - 12

INSTRUCTIONAL PLANNING SHEET

LEVEL III

CONCEPT

Color Code

DEPTH OF INSTRUCTION

3

LEARNING ACTIVITIES

The student will:

Read the values of resistors by using the color code.

Complete assignments in: Electricity and Electronics Basic
Steinberg/Ford
unit 12

INSTRUCTIONAL PLANNING SHEET

LEVEL III

CONCEPT

Ohm's Law

DEPTH OF INSTRUCTION

3

LEARNING ACTIVITIES

The student will be able to:

Explain mathematical relationships dealt with in Ohm's Law.

Complete assignments in: Electricity and Electronics Basic
Steinberg/Ford
unit 14

INSTRUCTIONAL PLANNING SHEET

LEVEL III

CONCEPT

Meters

DEPTH OF INSTRUCTION

3

LEARNING ACTIVITIES

The student will be able to:

Measure voltage and resistance using the VOM and VTVM.

INSTRUCTIONAL PLANNING SHEET

LEVEL III

CONCEPT

Basic Resistive Circuits

DEPTH OF INSTRUCTION

2

## LEARNING ACTIVITIES

The student will be able to:

Solve for total resistance, current, and voltage drops in the following types of circuits: series
parallel
combination series-parallel

Complete assignments in: Electricity and Electronics Basic
Steinberg/Ford
unit 15

INSTRUCTIONAL PLANNING SHEET

LEVEL III

CONCEPT

Magnetism

DEPTH OF INSTRUCTION

2

## LEARNING ACTIVITIES

The student will be able to:

State the basic laws of magnetism dealing with permanent electromagnets.

Complete assignments in: Electricity and Electronics Basic
Steinberg/Ford
units 4 - 5

The instructor will do a demonstration of permanent and electromagnetism.

INSTRUCTIONAL PLANNING SHEET

LEVEL III

CONCEPT

Introduction to AC Power

DEPTH OF INSTRUCTION

2

LEARNING ACTIVITIES

The student will be able to:

Explain how AC power is generated and used.

Complete assignemnts in: Electricity and Electronics Basic
Steinberg/Ford
unit 16

INSTRUCTIONAL PLANNING SHEET

LEVEL III

CONCEPT

Working Safely With Electricity

DEPTH OF INSTRUCTION

4

## LEARNING ACTIVITIES

The student will be able to:

Be able to tell what effect electricity has on the human body.

Identify hazardous electrical conditions.

List first aid procedure for shock victims.

Complete assemblers modules: Safety I EL-EA-03
Safety II EL-EA-04

INSTRUCTIONAL PLANNING SHEET

LEVEL III

CONCEPT

Motor Types

DEPTH OF INSTRUCTION

2

LEARNING ACTIVITIES

The student will be able to:

Explain the operation of universal and induction motors

Complete assignments in: Electricity and Electronics Basic
Steinberg/Ford
unit 22

INSTRUCTIONAL PLANNING SHEET

LEVEL III

CONCEPT

Transformers

DEPTH OF INSTRUCTION

3

## LEARNING ACTIVITIES

The student will be able to:

Explain the operation of a transformer:
- step up voltage
- step down voltage
- step up current
- step down current
- truns ratio

Complete assignments in: Electricity and Electronics Basic
Steinberg/Ford
unit 17

The instructor will do a demonstration of high voltage including safety information.

INSTRUCTIONAL PLANNING SHEET

LEVEL III

CONCEPT

Soldering and Wire Splices

DEPTH OF INSTRUCTION

3

LEARNING ACTIVITIES

The student will be able to:

Strip and splice wire using the following types of splices: western union
pigtail
tap

Prepare a soldering iron and select proper materials: solder type
flux type

Make a satisfactory solder connection.

Complete assignments in: Electricity and Electronics Basic
Steinberg/Ford
pages 433-436 (unit 31)

INSTRUCTIONAL PLANNING SHEET

LEVEL III

CONCEPT

Switches

DEPTH OF INSTRUCTION

3

LEARNING ACTIVITIES

The student will be able to:

Connect circuits using the following types of switches:

single ploe single throw
3 way
4 way

Complete assignments in: Electricity and Electronics Basic
Steinberg/Ford
unit 19

INSTRUCTIONAL PLANNING SHEET

LEVEL III

CONCEPT

Switching Logic

DEPTH OF INSTRUCTION

3

## LEARNING ACTIVITIES

The student will be able to:

Build and work with the following logic gate circuits:
- AND
- OR
- NOT (inverter)
- NAND
- NOR

Complete assignments in or review:
- Level II
- Exploration Sheet #12

INSTRUCTIONAL PLANNING SHEET

LEVEL III

CONCEPT

House Wiring

DEPTH OF INSTRUCTION

3

## LEARNING ACTIVITIES

The student will be able to:

Wire the following as outlined by the National Electrical Code:

duplex outlets
1 lamp controlled by 1 switch
1 lamp controlled by 2 switches

Complete assignments in: Electricity and Electronics Basic
Steinberg/Ford
units 18 - 19

INSTRUCTIONAL PLANNING SHEET

LEVEL III

CONCEPT

How to Read the Electric Kilowatt Meter

DEPTH OF INSTRUCTION

4

LEARNING ACTIVITIES

The student will be able to:

Explain the relationship between power, time, and the Kilowatt hour.

Determine the scheme of reading the dials on the Kilowatt hour meters.

Practice reading meter dials by solving a series of problems on paper.

Develop a sequence of reading the home power meter to determine the power used and the cost.

INSTRUCTIONAL PLANNING SHEET

LEVEL III

CONCEPT

Lighting Systems

DEPTH OF INSTRUCTION

3

LEARNING ACTIVITIES

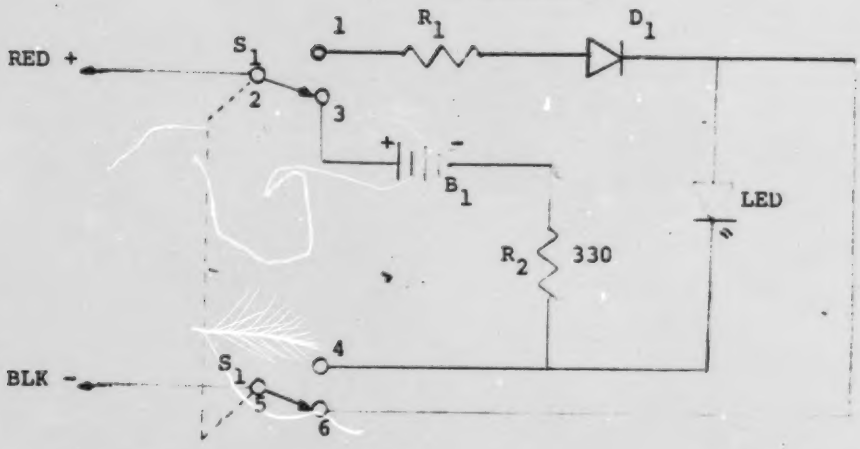
The student will be able to:

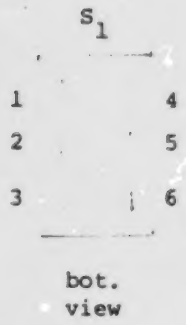
Explain operation and installation of: incandescent lighting circuits
flourescent lighting circuits

Complete assignments in: Electricity and Electronics Basic
Steinberg/Ford
unit 20

# CONTINUITY TESTER

## schematic

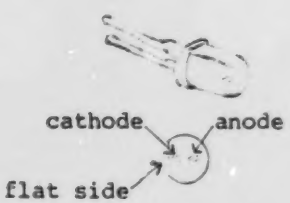



## parts list

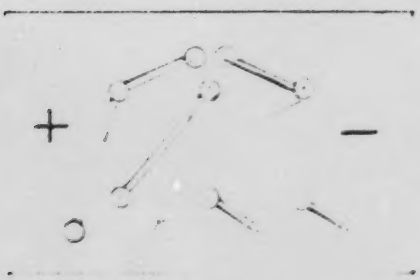
LED - light emitting diode
$D_1$ - diode, IN4001
$R_1$ - resistor, 560 ohm ½ watt
$R_2$ - resistor, 330 ohm ½ watt
$B_1$ - battery, 9 volt
$S_1$ - switch, DPDT
Test leads and clips
Case

LED

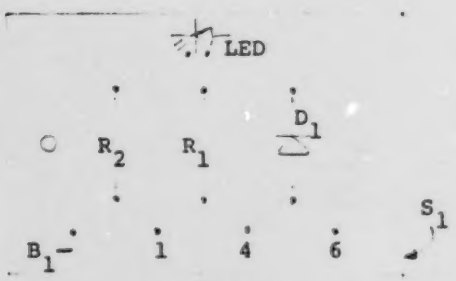



(cathode identified by flat on side of case)

## pc layout




foil side
continuity tester




parts side
continuity tester

## construction

Make the printed circuit board first, as shown on the diagram. Etch and clean the board, and drill for components. Mount components on the board as shown, and solder the leads. The LED is mounted at the very end of its leads, and then bent 180° so that it extends below the board and through the hole in the case. It should not extend more than 1/8 inch. Be sure the polarity of the diode and the LED are correct before soldering. Solder stranded hook-up wire in the remaining holes.

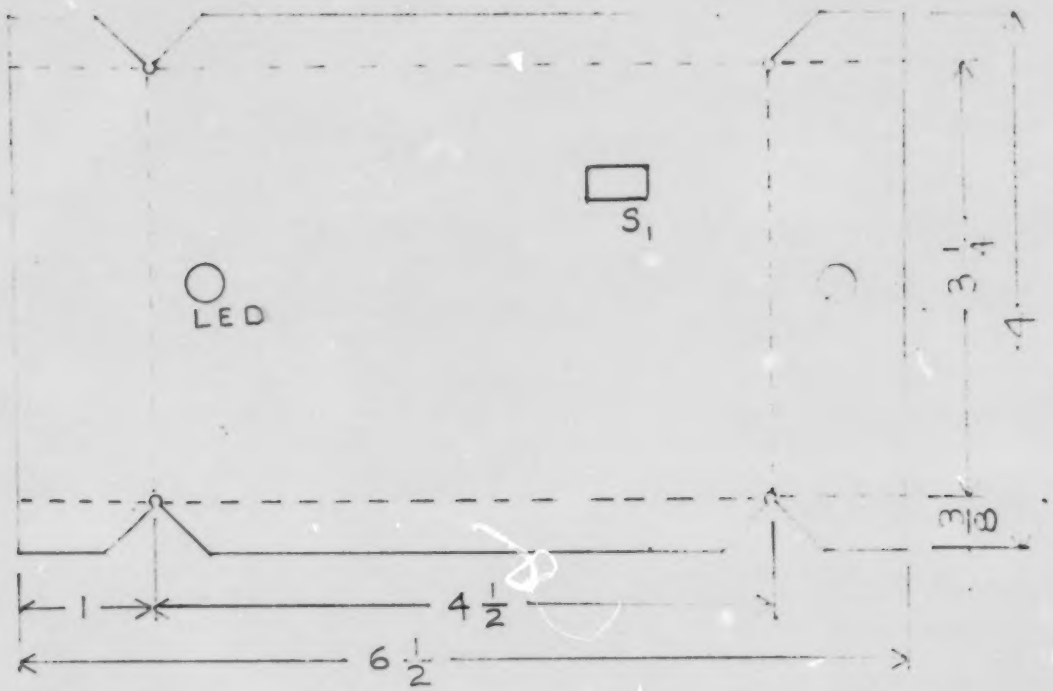
Make the metal case as shown on the diagram. Make all holes and openings before bending. Notice that on this style case the bottom fits into the top. Check your measurements carefully before bending. Cover the case with contact paper or paint as desired.

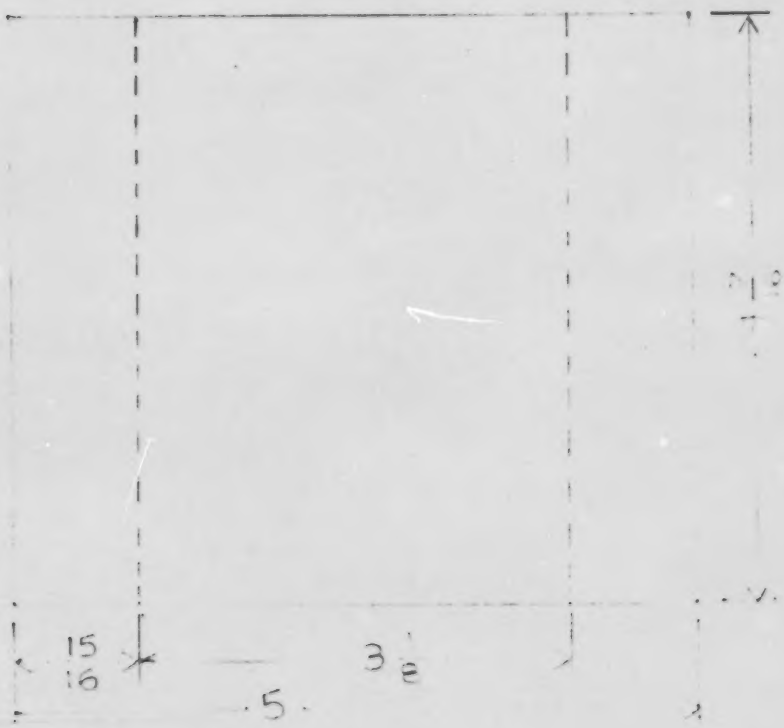
Carefully mount the printed circuit with spacers and machine screws so that the LED extends through the case slightly. Mount the switch and battery holder, and install a grommet in the test lead hole. Use the parts mounting diagram and the schematic to complete the wiring. Refer to the bottom view of switch $S_1$ when you connect the wires on the printed circuit board.

To test your project connect a 9 volt battery to the battery clip and touch the test leads together. The LED will light on one of the two switch positions. Label this position "continuity test." This position is used when making a continuity test on a component or a dead circuit.

In the other position the LED will light on AC or DC voltages up to about 15 volts. A DC voltage will produce a light only when the polarity matches the test leads (red for +, black for -), while an AC voltage will light the LED either way. Label this switch position "voltage test." This position is useful when testing circuits on a car or trailer.

**case**



## Transformer Construction

### Materials List

| | |
|---|---|
| iron lamination strips | wooden base block |
| thin cardboard | cloth tape |
| #28 magnet wire | sheet metal hold-downs |
| #18 magnet wire | nails and/or screws |
| line cord with plug | 4 terminals |

### Procedure

I. Iron Core
- A. Lamination strips
  1. Long pieces 2-7/8 " by 3/4 "
  2. Short pieces 1-1/2 " by 3/4 "
  3. Four pieces required per layer
  4. Build up to 3/4 " thickness

II. Primary winding
- A. Coil form
  1. Assemble coil form
  2. Insulate coil form with thin cardboard
  3. Do not tape insulation to wooden block
- B. Primary winding
  1. Wind on 1350 turns of #28 magnet wire
  2. Leave out an 8 " lead on each end
  3. Insulate the primary coil before starting the secondary coil

III. Secondary winding
- A. Leave out 8 " lead
- B. Wind on 50 turns of #18 magnet wire
- C. Bring out a 7 " loop
- D. Wind on 25 turns more in the same rotation
- E. Bring out a 7 " loop
- F. Wind on 25 turns more in the same rotation
- G. Bring out an 8 " loop
- H. Remove wire from coil form and wrap with cloth tape

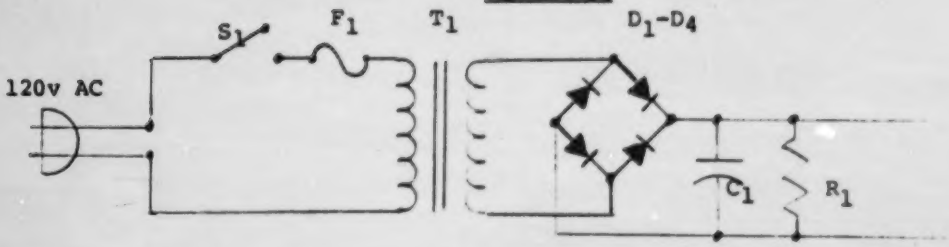
IV. Assembly
- A. Open corner of laminations and insert coil on core
- B. Build hold-downs from sheet metal
- C. Drill hole for wires to go down through
- D. Drill four holes for terminals
- E. Fasten transformer to base block
- F. Singles attatch to outer terminals -- loops attatch to center terminals
- G. Small wires attatch to cord brought from home
- H. Bring to instructor for voltage readout

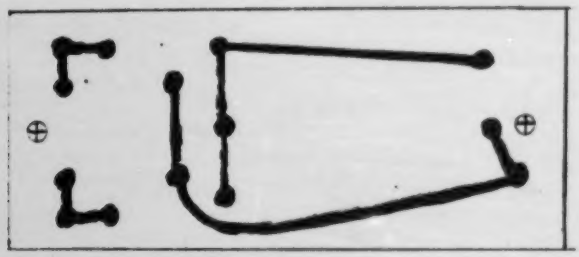
The starting and stopping of alternating current causes a magnetic field to form and collapse around the wire with each start and stop of the AC. This building up and collapsing magnetic field, if placed near another coil of wire, will cut through that second coil causing the electrons to move through the wire. This movement of electrons is electricity which can be used for work.

The steel core is used to better transmit the magnetic lines of force so they cut through the secondary winding rather than being lost in air.

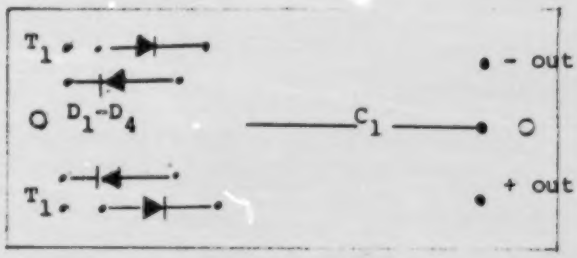
## Power Supply Construction Information

schematic



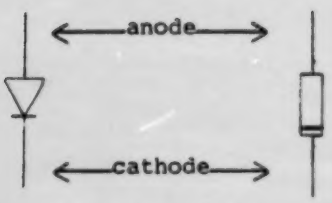
foil side



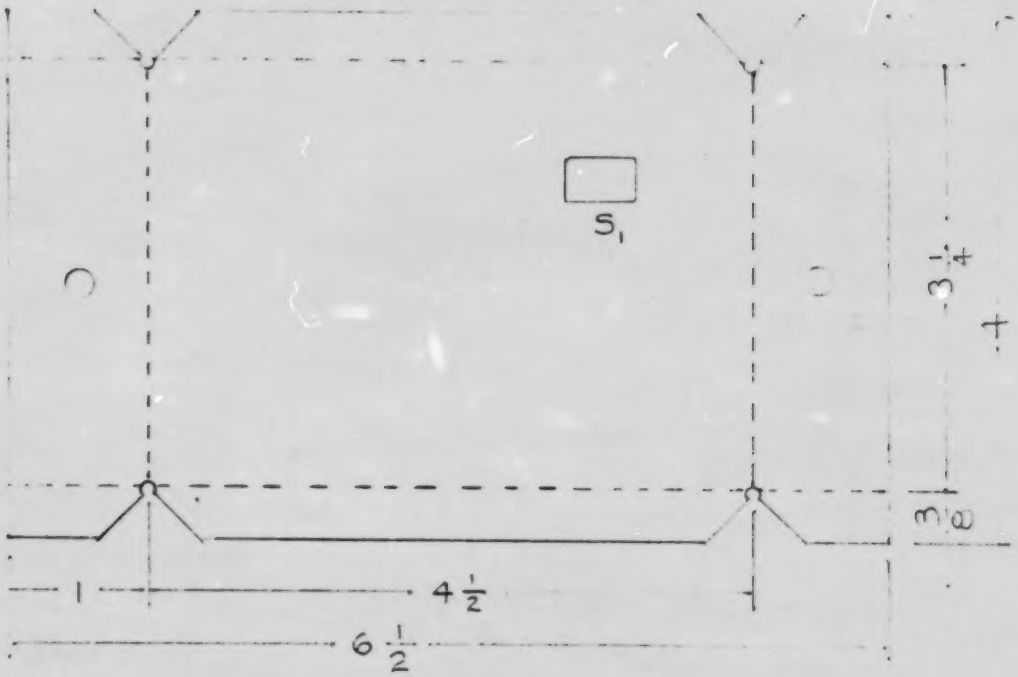

parts side

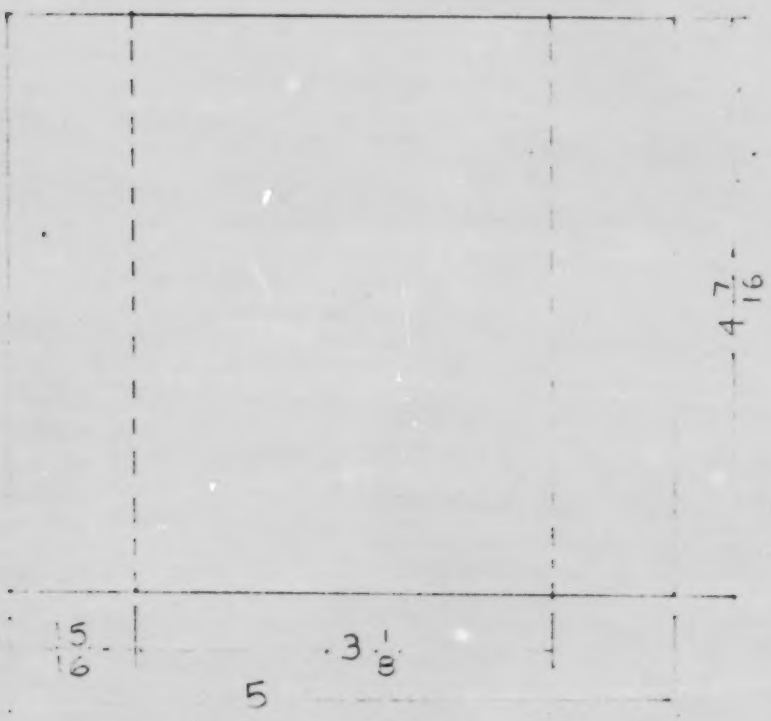
## parts list

$D_1$-$D_4$ - silicon diode, 100 PIV 1A IN4002 or equal
$T_1$ - transformer, 12.6v 1A
$C_1$ - capacitor 100-200mfd 25v
$S_1$ - switch, SPST
$F_1$ - 1A fuse
case - 20ga aluminum

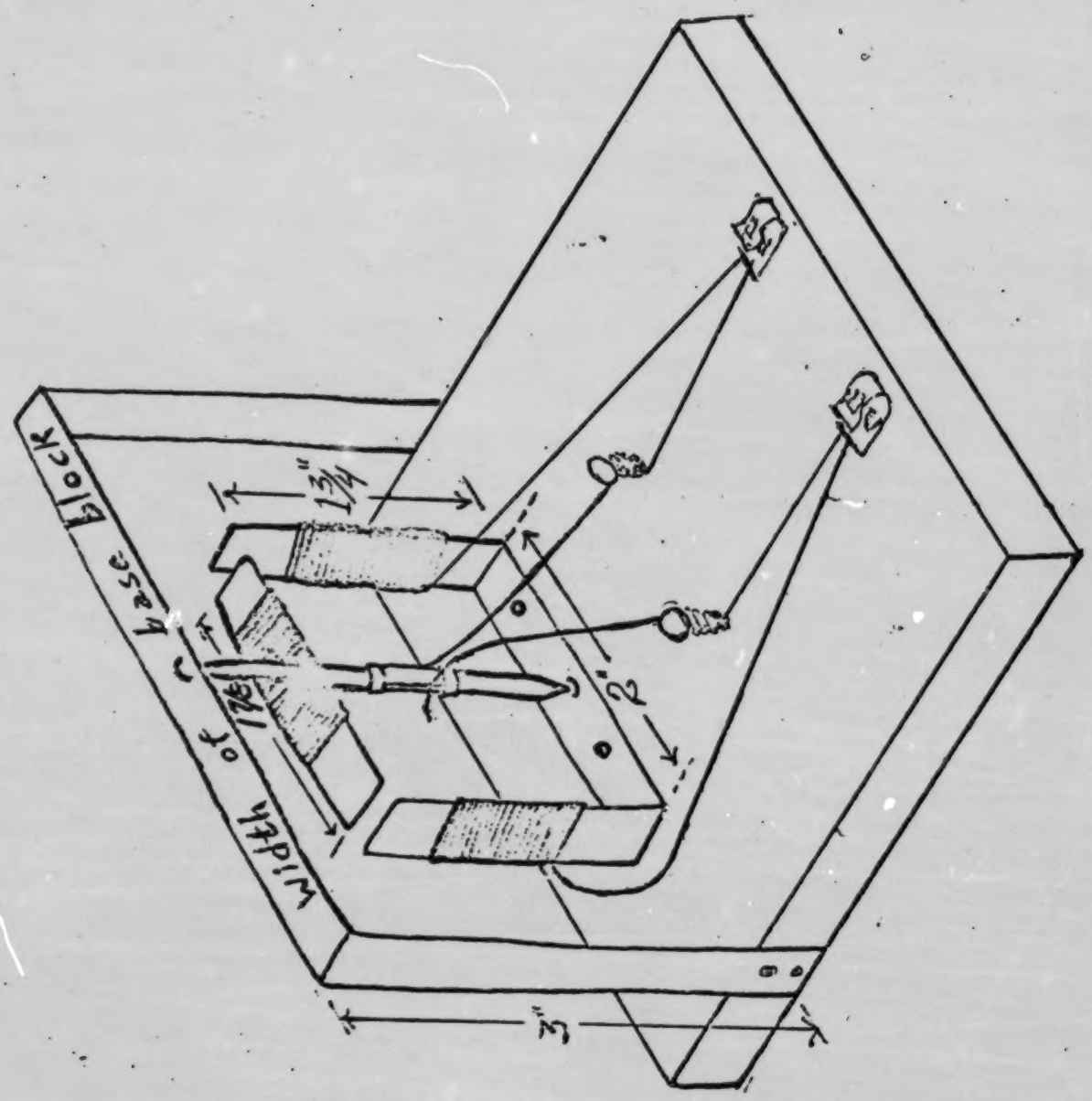



$D_1$ - $D_4$
diode polarity


S1
3 1/4
3/8
1
4 1/2
6 1/2


4 7/16
5/16
3 1/8
5

DC MOTOR



## LEVEL IV

### Concept List

1. Basics of DC EIR&P
2. Resistors and Color Code
3. Voltage Sources (batteries)
4. Ohm's Law
5. Electrical Power
6. Series DC Resistance
7. Parallel DC Resistance
8. Series - Parallel
9. Diodes
10. Basic Transistors
11. Capacitor Fundamentals
12. Basics of Alternating Current
13. Magnetic Theories
14. Characteristics of Inductors
15. Types of Inductors
16. Mutual Inductance
17. Power Transformers
18. Basic Soldering
19. Motor Scales
20. Use of VOM & VTVM
21. Setting Up the Oscilloscope
22. Measuring Voltage, etc. With the Oscilloscope
23. Introduction to Switching and Relays
24. Power Supply Construction
25. Audio Amplifiers
26. Oscillators
27. Project Construction

INSTRUCTIONAL PLANNING SHEET

LEVEL IV

CONCEPT

Basics of DC (Voltage, Current, Resistance, and Power)

DEPTH OF INSTRUCTION

5

LEARNING ACTIVITIES

The student will:

1. Read background information
2. Classroom discussion
3. Observe instructor demonstrations and illustrations
4. Name and define the four factors of electricity
5. Describe the actions in a circuit for changing values of voltage, current, resistance, and power.
6. Complete package Basics of Direct Current #EL-BE-05

INSTRUCTIONAL PLANNING SHEET

LEVEL IV

CONCEPT

Resistors and Color Code

DEPTH OF INSTRUCTION

5

LEARNING ACTIVITIES

The student will:

1. Review Level I resistor Exploration Sheet
2. Be introduced to the five band color code
3. Be able to identify different wattages of resistors
4. Be able to identify resistance values less than ten (10) ohms less than one (1) ohm
5. Be able to identify different types of resistors
6. Complete package Color Code and Resistors #EL-BE-10

INSTRUCTIONAL PLANNING SHEET

LEVEL IV

CONCEPT

Voltage Sources

DEPTH OF INSTRUCTION

5

LEARNING ACTIVITIES

The student will:

1. Observe instructor demonstration on different types of batteries
2. Demonstrate a knowledge of the characteristics of various batteries
3. Connect different batteries to a voltage source and observe charging current.
4. Set up a power supply to a specific voltage level
5. Complete package Voltage Sources #EL-BE-08

INSTRUCTIONAL PLANNING SHEET

LEVEL IV

CONCEPT

Ohm's Law

DEPTH OF INSTRUCTION

5

## LEARNING ACTIVITIES

The student will:

1. Review the Exploration Sheet from Level II on Ohm's Law and Power Relationships.
2. View a demonstration on the relationships between voltage, ampere, and resistance.
3. Verify these relationships through practical application of Ohm's Law.
4. Complete the package Ohm's Law #EL-BE-15.

INSTRUCTIONAL PLANNING SHEET

LEVEL IV

CONCEPT

Electrical Power

DEPTH OF INSTRUCTION

5

## LEARNING ACTIVITIES

The student will:

1. Review Levels I, II, and III Exploration Sheets on electrical power:

   Level I: Exploring the Factors of Voltage and Power
   Level II: Ohm's Law and Power Relationships
   Level III: Ohm's Law Relationships

2. Become familiar with the power consumption of household appliances.

3. Become aware of the relationship between power consumption and wire size.

4. Be able to select the correct wire size for different electrical project applications.

5. Complete package Power and Watt's Law #EL-BE-16

INSTRUCTIONAL PLANNING SHEET

LEVEL IV

CONCEPT

Series Resistive Circuits

DEPTH OF INSTRUCTION

5

LEARNING ACTIVITIES

The student will:

1. Review the Exploration Sheets from Levels I, II, and III on series circuits,
2. Solve series circuit problems for current, voltage, power, and resistance.
3. Connect series circuits and measure circuit values.
4. Calculate for total resistance, sum of voltage drops, and current levels.
5. Complete package Series Resistive Circuits #EL-BE-20.

INSTRUCTIONAL PLANNING SHEET

LEVEL IV

CONCEPT

Parallel Resistive Circuits

DEPTH OF INSTRUCTION

5

LEARNING ACTIVITIES

The student will:

1. Review the Exploration Sheets from Levels I, II, and III on parallel circuits.
2. Solve parallel circuit problems for current, voltage, power, and resistance.
3. Connect a parallel circuit and measure the resistance of each path.
4. Calculate for total resistance and current through each path.
5. Complete package Parallel Resistive Circuits #EL-BE-21.

INSTRUCTIONAL PLANNING SHEET

LEVEL IV

CONCEPT

Series-Parallel Resistive Circuits

DEPTH OF INSTRUCTION

5

LEARNING ACTIVITIES

The student will:

1. Take part in a classroom instructor presentation of series-parallel combination circuits.
2. Solve series-parallel circuit problems for current, voltage, power, and resistance.
3. Connect a series-parallel resistive circuit and measure voltage applied to the circuit, total current through the circuit, and the resistance across each resistor.
4. Calculate for total resistance and voltage drops across each resistor.
5. Complete package Series-Parallel Resistance Circuits #EL-BE-22

INSTRUCTIONAL PLANNING SHEET

LEVEL IV

CONCEPT

Diodes

DEPTH OF INSTRUCTION

6

## LEARNING ACTIVITIES

The student will:

1. Revies the Exploration Sheet from Level II on diodes.
2. Take part in classroom discussion.
3. Observe an instructor demonstration and illustrations of diode circuit operation.
4. Complete package Diodes As Rectifiers #EL-BE-29
5. Construct: A. a half wave rectifier circuit.
   B. a full wave rectifier circuit.
6. Complete package Diodes In Circuits #EL-BE-28.

INSTRUCTIONAL PLANNING SHEET

LEVEL IV

CONCEPT

Basic Transistors

DEPTH OF INSTRUCTION

6

## LEARNING ACTIVITIES

The student will:

1. Review the Exploration Sheets from Levels I smf II on transistor identification and testing.
2. Complete package Basic Transistors #EL-BE-30.
3. Observe a presentation on transistor operation.
4. Complete package Basic Transistor Operation #EL-BE-32.
5. Construct a basic transistor amplifier circuit and take measurements in the correct locations in the circuit.
6. Determine if the circuit is operating properly by the results of voltage measurements.

INSTRUCTIONAL PLANNING SHEET

LEVEL IV

CONCEPT

Capacitor Fundamentals

DEPTH OF INSTRUCTION

5

## LEARNING ACTIVITIES

The student will:

1. Review the Exploration Sheet from Level I on capacitors.
2. Become acquainted with the capacitor and voltage ratings of capacitors.
3. Be able to identify various types of capacitors.
4. Complete packages Types of Capacitors #EL-BE-38
   Capacitor Fundamentals #EL-BE-37.
5. Test various types of capacitors to determine if they are defective or operational.

INSTRUCTIONAL PLANNING SHEET

LEVEL IV

CONCEPT

Basics of Alternating Current

DEPTH OF INSTRUCTION

5

LEARNING ACTIVITIES

The student will:

1. Review the Exploration Sheets from Levels II and III on alternating current.
2. Observe a demonstration on the generation of AC voltages.
3. Observe instructor demonstration and illustrations of RMS, peak, and peak-to-peak AC voltages.
4. Complete packages Basics of Alternating Current #EL-BE-25
   Measuring Alternating Current With the Oscilloscope #EL-BE-26
5. View different AC waveforms on the oscilloscope.

INSTRUCTIONAL PLANNING SHEET

LEVEL IV

CONCEPT

Magnetic Theories

DEPTH OF INSTRUCTION

5

LEARNING ACTIVITIES

The student will:

1. Perform experiments to:
   A. Identify magnet types
   B. Explain magnetic laws
   C. Wind types of coils.
2. Observe and discuss instructor demonstrations of magnetic actions using a magnetic generator.
3. Complete package Magnetism #EL-BE-45. (including the evaluation)

INSTRUCTIONAL PLANNING SHEET

LEVEL IV

CONCEPT

Characteristics of Inductors

DEPTH OF INSTRUCTION

5

LEARNING ACTIVITIES

The student will:

1. Take part in a classroom information discussion.
2. Observe demonstrations of magnetic devices.
3. Set up an experiment to demonstrate inductance and motor action.
4. Complete package Characteristics of Inductors #EL-BE-46.

INSTRUCTIONAL PLANNING SHEET

LEVEL IV

CONCEPT

Types of Inductors

DEPTH OF INSTRUCTION

5

LEARNING ACTIVITIES

The student will:

1. Take part in a classroom information session on types of inductive devices.
2. Draw the symbols for the most common types of inductive devices.
3. Test inductors for shorted or open windings.
4. Complete package Types of Inductors #EL-BE-47.

INSTRUCTIONAL PLANNING SHEET

LEVEL IV

CONCEPT

Mutual Inductance

DEPTH OF INSTRUCTION

5

LEARNING ACTIVITIES

The student will:

1. Review basic inductance from Levels I, II, and III. (Classroom discussion).
2. Identify the leads from each winding on a multi-winding transformer.
3. Observe instructor's demonstration of transformer action.
4. Review package Mutual Inductance #EL-BE-50.

INSTRUCTIONAL PLANNING SHEET

LEVEL IV

CONCEPT

Power Transformers

DEPTH OF INSTRUCTION

5

LEARNING ACTIVITIES

The student will:

1. Review applications of transformers in Levels II and III.
2. Observe the instructor's classroom demonstration of a model transformer problem.
3. Determine the isolation between windings.
4. Measure voltages input and out put to determine the 'turns ratio'.
5. Complete package Power Transformers #EL-BE-51.

INSTRUCTIONAL PLANNING SHEET

LEVEL IV

CONCEPT

The Basics of Soldering

DEPTH OF INSTRUCTION

7

## LEARNING ACTIVITIES

The student will:

1. Review the theory and skills of soldering from Levels I, II, and III.
2. Cut, strip, fasten, and solder wired to terminal lugs to industrial standards.
3. Stuff and solder components onto a circuit board (preform all leads).
4. Complete package Basics of Soldering #EL-BE-06
5. Review packages:
   - Basic Soldering #EL-BE-21
   - Precision Soldering #EL-BE-22
   - Quality Control #EL-BE-23
   - Desoldering #EL-EA-24

INSTRUCTIONAL PLANNING SHEET

LEVEL IV

CONCEPT

Meter Scales

DEPTH OF INSTRUCTION

7

LEARNING ACTIVITIES

The student will:

1. Review meter scale theory from Levels I,II, and III.
2. Record values as read from meter scales.
3. Use range and multiplier systems to read scales of voltage and resistance.
4. Complete package Reading Scales #EL-BE-12.

INSTRUCTIONAL PLANNING SHEET

LEVEL IV

CONCEPT

Using the VOM and or VTVM

DEPTH OF INSTRUCTION

7

LEARNING ACTIVITIES

The student will:

1. Review VTVM set up and range systems from Levels I, II, and III.
2. Measure DC voltages.
3. Measure AC voltages.
4. Measure resistance
5. Complete package Using a VOM #EL-BE-13

(At this level it is suggested that current measures NOT be taken due to possible meter damage. Values of current can be calculated if resistance and voltage are known.)

INSTRUCTIONAL PLANNING SHEET

LEVEL IV

CONCEPT

Oscilloscope Set Up

DEPTH OF INSTRUCTION

5

LEARNING ACTIVITIES

The student will:

1. Review basic oscilloscope set up from Levels II and III.
2. Study theory of the CRT and basic scope construction using block analysis.
3. Know the different types of sweep/time base systems used in older and newer types of oscilloscopes.
4. List oscilloscope specifications and be able to tell what each means.
5. Complete package Oscilloscipe Operation #EL-BE-24.
   (This package can be modified to fir the classroom scopes.)

INSTRUCTIONAL PLANNING SHEET

LEVEL IV

CONCEPT

Measuring Alternating Current With the Oscilloscope

DEPTH OF INSTRUCTION

5

LEARNING ACTIVITIES

The student will:

1. Review the basics of AC: package #EL-BE-25
   frequency
   period
   peak
   peak-to-peak
   RMS values

2. Review the basic scope set up from previous package #EL-BE-24.

3. Set up to display AC waveforms.

4. 'Calculate' the time base and vertical volts/devision control.

5. Select proper probe set up.

6. Complete package Measuring Alternating Current With the Oscilloscope #EL-BE-26.

(The instructor must 'condition' the presentation above to the classroom scope used.)

INSTRUCTIONAL PLANNING SHEET

LEVEL IV

CONCEPT

Introduction to Switching and Relays

DEPTH OF INSTRUCTION

6

LEARNING ACTIVITIES

The student will:

1. Take part in an instructor-demonstration of switch and relay operation.
2. Identify switch types.
3. Connect a basic switch circuit.
4. Draw operational circuit diagrams using switches.
5. Complete package Switches and Relays #EL-BE-23.

INSTRUCTIONAL PLANNING SHEET

LEVEL IV

CONCEPT

Power Supply Construction

DEPTH OF INSTRUCTION

5

## LEARNING ACTIVITIES

The student will:

1. Review power supply lay out from Level II.
2. Review package Power Transformers #EL-BE-51.
3. Review package Diodes in Circuits #EL-BE-28.
4. Review safety practices for using line voltages.
5. Construct a chassis for mounting power supply components.
6. Mount components:
   1. switch-line cord-fuse
   2. transformers
   3. full wave rectifier bridge
   4. filter system
   5. voltage divider out put and terminals.
7. Test power supply with voltmeter and scope.

INSTRUCTIONAL PLANNING SHEET

LEVEL IV

CONCEPT

Basic Amplifier

DEPTH OF INSTRUCTION

4

LEARNING ACTIVITIES

The student will:

1. Identify basic transistor amplification configurations. (CE, CB, CC)
2. Build and test a CE amp using a breadboard, oscilloscope, and audio generator.
3. Calculate voltage gain and then observe amplified waveform on the oscilloscope.
4. Build a two stage audio amplifier from a given schematic diagram and printed circuit board.

INSTRUCTIONAL PLANNING SHEET

LEVEL IV

CONCEPT

Oscillators

DEPTH OF INSTRUCTION

4

LEARNING ACTIVITIES

The student will:

1. Review basic oscillator fundamentals in
   Exploring electronics basic fundamentals
   Howard H. Gerrish
   Unit II

2. Build an audio oscillator circuit using a breadboard.

3. Test the audio oscillator by using an oscilloscope and amplifier.

INSTRUCTIONAL PLANNING SHEET

LEVEL IV

CONCEPT

Project Construction

DEPTH OF INSTRUCTION

6

LEARNING ACTIVITIES

The student will:

1. Review safety practices for metal-plastic working tool safety and electrical safety.
2. Make a circuit board from a predesigned circuit.
3. Stuff components on the circuit board.
4. Solder the circuit components in place.
5. Test the circuit by inspection and operation.

(NOTE: Steps 3,4, and 5 could be done in sections to provide better circuit understanding. Build power supply section first, etc.)

6. Build an enclosure for the project.
7. Pass final inspection.
8. The instructor should refer to package Instructor's Project Guide #EL-BE-00-B.

   Project ideas and construction techniques are covered in this package.

## LEVEL V

Instructional Units:

1. Electrical Construction and Troubleshooting Techniques
2. Power Supplies
3. Solid State Devices
4. Amplification
5. Digital Fundamentals
6. Projects

## LEVEL V

Electrical Construction and Troubleshooting Techniques

1. Component Identification
2. Soldering
3. Mechanical Assembly
4. Circuit Board Layout
5. Wire Wrap
6. Basic Troubleshooting Fundamentals

INSTRUCTIONAL PLANNING SHEET

LEVEL V

CONCEPT

Vocational Level I

Component Identification

DEPTH OF INSTRUCTION

5

LEARNING ACTIVITIES

The Student Will:

1. Be able to identify the following components:
   (refer to the electronics assembly packages)

   1. resistors EL - EA - 16
   2. capacitors EL - EA - 17
   3. inductors EL - EA - 17
   4. diodes EL - EA - 18
   5. transistors EL - EA - 18
   6. IC's EL - EA - 18
   7. electrical hardware
      a. lamps EL - EA - 19
      b. switches EL - EA - 19
      c. fuses EL - EA - 19
      d. fastenings EL - EA - 19

INSTRUCTIONAL PLANNING SHEET

LEVEL V

CONCEPT

Soldering

DEPTH OF INSTRUCTION

6

LEARNING ACTIVITIES

The Student Will:

1. Prepare wire for soldering and solder.

   Refer to electronics assembly packages:

   A. Wire preperation

      1. Stripping EL - EA - 14

      2. Harness making EL - EA - 15

   B. Soldering

      1. Care and use of soldering equipment EL - EA - 20

      2. Basic soldering EL - EA - 21

      3. Precision soldering EL - EA - 22

      4. Quality control EL - EA - 23

      5. Desoldering EL - EA - 24

INSTRUCTIONAL PLANNING SHEET

LEVEL V

CONCEPT

Mechanical Assembly

DEPTH OF INSTRUCTION

6

LEARNING ACTIVITIES

The student will be able to do the following mechanical operations. These will be accomplished by making a chassis.

A. Drilling

B. Punching

C Fasteners

1. screws
2. pop-rivets
3. washers
4. tools
   a. screwdrivers
   b. nutdrivers
   c. allen wrenches
   d. spline wrenches

D. Chassis layout

E. Metal bending

INSTRUCTIONAL PLANNING SHEET

LEVEL V

CONCEPT

Circuit Board Layout

DEPTH OF INSTRUCTION

5

LEARNING ACTIVITIES

The Student Will:

be able to lay out a simple printed circuit board from a schematic. This will be accomplished by building the following suggested circuits from the schematic and discrete components:

1. Circuit tracer
2. Multivibrator

INSTRUCTIONAL PLANNING SHEET

LEVEL V

CONCEPT

Wire Wrap

DEPTH OF INSTRUCTION

6

LEARNING ACTIVITIES

The Student Will:

I. Construct a wire-wrap connection system with 31 wires.
(refer to Electronic Assembly: Wire Wrap — Level I EL - EA - 25.)

II. Use a wire call sheet to place 90 wires with 100% accuracy on a 192 pin wire-wrap grid.
(Refer to Electronic Assembly: Wire Wrap — Level II EL - EA - 26.)

INSTRUCTIONAL PLANNING SHEET

LEVEL V

CONCEPT

Basic Troubleshooting Fundamentals

DEPTH OF INSTRUCTION

6

LEARNING ACTIVITIES

The student will be able to solve simple electrical problems by:

A. Problem identification

1. faulty components

2. shorts

3. opens

B. Block analysis

LEVEL V

Power Supplies

INSTRUCTIONAL PLANNING SHEET

LEVEL V

CONCEPT

Power Supplies

DEPTH OF INSTRUCTION

7

LEARNING ACTIVITIES

The Student Will:

A. Review full wave and half wave rectification and filtering.

B. Study and construct the following

1. voltage doublers
2. bi-polar supplies
3. voltage dividers
4. voltage regulators
   a. zener
   b. series pass

## LEVEL V

Solid State Devices:

1. Transistor Review
2. Transistor Biasing
3. Field Effect Transistor
4. SCR and TRIAC

INSTRUCTIONAL PLANNING SHEET

LEVEL V

CONCEPT

Transistor Review

DEPTH OF INSTRUCTION

6

LEARNING ACTIVITIES

The Student will review:

Basic Transistor Operation EL - EB - 30,31,32

INSTRUCTIONAL PLANNING SHEET

LEVEL V

CONCEPT

Transistor Biasing

DEPTH OF INSTRUCTION

6

LEARNING ACTIVITIES

The Student Will:

A. Identify various biasing methods used in transistor amplifiers.

B. Construct and test various biasing networks.

INSTRUCTIONAL PLANNING SHEET

LEVEL V

CONCEPT

Field Effect Transistor (FET)

DEPTH OF INSTRUCTION

5

LEARNING ACTIVITIES

The Student Will:

A. Identify various types of FET's (MOSFET, JFET)

B. Construct and test various FET circuits.

INSTRUCTIONAL PLANNING SHEET

LEVEL V

CONCEPT

SCR and TRIAC

DEPTH OF INSTRUCTION

5

LEARNING ACTIVITIES

The Student Will:

A. Identify various types of SCR and TRIAC packages.

B. Identify the electrical characteristics of the SCR and TRIAC.

## LEVEL V

Amplification

1. Amplifier Configurations CE, CB, CC
2. Power Amplifier
3. Negative Feed Back
4. Operational Amplifier (OP-AMP)

INSTRUCTIONAL PLANNING SHEET

LEVEL V

CONCEPT

Amplifier Study: Amplifier Configurations

DEPTH OF INSTRUCTION

6

LEARNING ACTIVITIES

The Student Will:

A. Identify three basic amplifier configurations CE, CB, CC.

B. Distinguish the important characteristics of each amplifier configuration.

1. Input impedance
2. Output impedance
3. Voltage gain
4. Current gain

INSTRUCTIONAL PLANNING SHEET

LEVEL V

CONCEPT

Amplifier Study: Power Amplifier

DEPTH OF INSTRUCTION

6

LEARNING ACTIVITIES

The Student Will:

A. Identify, test, and mount various power transistors.

B. Identify the various types of power amplifier couplings:

   1. transformer

   2. RC

   3. direct

C. Construct and test various power amplifier configurations:

   1. single ended

   2. push-pull

   3. quasi-complimentary

INSTRUCTIONAL PLANNING SHEET

LEVEL V

CONCEPT

Amplifier Study: Negative Feedback

DEPTH OF INSTRUCTION

6

LEARNING ACTIVITIES

The Student Will:

A. Identify various types of negative feedback networks.

1. gain control

2. frequency response

3. linearity

INSTRUCTIONAL PLANNING SHEET

LEVEL V

CONCEPT

Amplifier Study: Operational Amplifier (Op-Amp)

DEPTH OF INSTRUCTION

6

LEARNING ACTIVITIES

The Student Will:

A. Identify the electrical characteristics of the Op-amp.

B. Set voltage in the inverting and non-inverting modes.
Refer to Operational Amplifiers EL - BE - 43.

C. Construct and test an Op-amp audio amplifier or power supply voltage regulator.

LEVEL V

Digital Fundamentals

1. Binary Numbers
2. Binary Codes
3. Digital Logic Gates
4. Boolean Algebra Fundamentals
5. Basic Flip-Flops
6. Decoder and Encoder
7. Shift Registers and Clocks
8. Binary Counters and BCD Counters

INSTRUCTIONAL PLANNING SHEET

LEVEL V

CONCEPT

Digital Fundamentals: Binary Numbers

DEPTH OF INSTRUCTION

6

LEARNING ACTIVITIES

The Student Will:

1. Be able to convert any binary number to a decimal number.
2. Be able to convert any decimal number to a binary number.
3. Take a list of decimal numbers and convert it into its binary coded decimal (BCD) equivalent.
4. Be able to convert any BCD number into its decimal equivalent.
5. Convert from binary to hexadecimal.
6. Convert from octal TO binary.

INSTRUCTIONAL PLANNING SHEET

LEVEL V

CONCEPT

Binary Codes

DEPTH OF INSTRUCTION

5

LEARNING ACTIVITIES

The Student Will:

A. Be able to represent a decimal number in BCD notation.

B. Be able to recognize and know the advantage of following codes:

1. Excess 3 code
2. Gray code
3. ASCII code

INSTRUCTIONAL PLANNING SHEET

LEVEL V

CONCEPT

Digital Logic Gates

DEPTH OF INSTRUCTION

5

LEARNING ACTIVITIES

The Student Will:

1. Review Level II logic Exploration Sheets.
2. Be able to draw the schematic and explain the operation of both diode and switch contact AND gates.
3. Be able to draw the schematic and explain the operation of both diode and switch contact OR gates.
4. Be able to write the truth table for any of the basic logic functions: AND, OR, NOT, NAND, NOR.
5. Be able to identify the industry standards symbols for inverters, AND, OR, NOT, NAND, NOR from a list of symbols.

INSTRUCTIONAL PLANNING SHEET

LEVEL V

CONCEPT

Boolean Algebra Fundamentals

DEPTH OF INSTRUCTION

5

LEARNING ACTIVITIES

The Student Will:

1. Write the Boolean expression for the following logic gates: AND, OR, NOT, NAND, NOR.
2. Minimize a given logic expression using the rules of Boolean algebra.
3. Write the Boolean expression corresponding to a given logic circuit.
4. Draw a logic circuit corresponding to a given Boolean expression.

INSTRUCTIONAL PLANNING SHEET

LEVEL V

CONCEPT

Basic Flip-Flops

DEPTH OF INSTRUCTION

6

LEARNING ACTIVITIES

1. Given a logic diagram, you will be able to identify each of the three types of flip-flops from their symbols.
2. You will be able to draw the symbols and detailed logic diagrams of the RS, D, and JK flip-flops.
3. Given a truth table of the RS, D or JK flip-flops showing all possible input conditions, you will be able to fill in the appropriate out put state for each.
4. Given a set of input waveforms for the RS, D, or JK flip-flop, you will be able to draw the corresponding out put waveforms.

INSTRUCTIONAL PLANNING SHEET

LEVEL V

CONCEPT

Digital Fundamentals: Decoder and Encoder

DEPTH OF INSTRUCTION

6

LEARNING ACTIVITIES

The Student Will:

1. Implement a decoder for any states with NAND, OR, NOR gates.
2. Write the output states of a decoder, encoder, multiplexer, when given the input states.
3. Build a digital counting circuit and a digital clock.

INSTRUCTIONAL PLANNING SHEET

LEVEL V

CONCEPT

Digital Fundamentals: Digital Sequential Logic --

Shift Registers and Clocks

DEPTH OF INSTRUCTION

6

LEARNING ACTIVITIES

The Student Will:

1. Construct a four bit shift register made with JK flip-flops.
2. Build an astable multivibrator clock oscillator.
3. Explain the function of a clock oscillator.

INSTRUCTIONAL PLANNING SHEET

LEVEL V

CONCEPT

Digital Fundamentals: Digital Sequential Logic --

Binary Counters and BCD Counters

DEPTH OF INSTRUCTION

7

LEARNING ACTIVITIES

The Student Will:

1. Construct a binary counter and explain its operation.
2. Determine the maximum count capability of a binary or BCD counter given the number of flip-flops it contains and a logic diagram.
3. Determine the count sequence of a counter from a logic diagram and draw the circuit waveforms.

## LEVEL VI

Instructional Units:

1. AM - FM Radio
2. Audio Systems
3. Television Systems
4. Digital Systems and Microprocessors
5. Solid State Devices II
6. Appliance Repair

## LEVEL VI

## AM - FM Radio Unit

Concept List

1. Audio Stage
2. Oscillator Stage
3. IF Amplifier
4. Detector and AGC
5. AM Receiver Troubleshooting
6. Basic FM Communications

INSTRUCTIONAL PLANNING SHEET

LEVEL VI

CONCEPT

AM Receiver: Audio Stage

DEPTH OF INSTRUCTION

7

LEARNING ACTIVITIES

The Student Will:

A. Build the audio section of an AM receiver on a bread-board.

B. Determine the proper operation of the audio section by comparing against known standards:

1. D/C current measurements

2. Voltage gain

3. D/C voltage and bias

F-1

INSTRUCTIONAL PLANNING SHEET

LEVEL VI

CONCEPT

AM Receivers: Oscillators

DEPTH OF INSTRUCTION

7

LEARNING ACTIVITIES

The Student Will:

A. Identify and describe the action of the

1. Armstrong oscillator
2. Hartley oscillator
3. Heterodyning process

B. Build and test the mixer-oscillator of an AM receiver on a bread-board.

1. D/C current measurements
2. Oscillator test
3. Operational test

INSTRUCTIONAL PLANNING SHEET

LEVEL VI

CONCEPT

AM Receiver: IF Amplifier

DEPTH OF INSTRUCTION

7

LEARNING ACTIVITIES

The Student Will:

A. Identify and describe the action of

1. RF filters
2. IF amplifiers

B. Build and test the IF amplifier stages.

1. D/C current measurement
2. Operational test
3. Bandwidth measurements
4. Frequency alignment

INSTRUCTIONAL PLANNING SHEET

LEVEL VI

CONCEPT

AM Receiver: Detector and AGC

DEPTH OF INSTRUCTION

7

LEARNING ACTIVITIES

The Student Will:

A. Build and test a detector and AGC circuit.

1. D/C current measurements
2. Operational test
3. Explore modulated RF detection
4. Explore AGC

INSTRUCTIONAL PLANNING SHEET

LEVEL VI

CONCEPT

AM Receiver: Troubleshooting

DEPTH OF INSTRUCTION

7

LEARNING ACTIVITIES

The Student Will:

A. Troubleshoot each individual circuit by:

1. Signal injection
2. Signal tracing
3. Voltage measurements
4. Resistance measurements

CONCEPT

Basic FM Communications

DEPTH OF INSTRUCTION

7

## LEARNING ACTIVITIES

The Student Will:

1. Review AM communications systems.
2. Study the frequency spectrum and know the allocations for standard broadcast FM band.
3. Determine how the FM modulation takes place.
4. Determine how the FM demodulation takes place.
5. Study the block diagram for the RM receiver and be able to explain the function of each block.
6. Discover how the multiplex system operates for stereo receivers.

## LEVEL VI

## Audio systems

Concept List:

1. Sound and Acoustical Fundamentals
2. Speakers and Enclosures
3. Monaural and Mutichannel Systems
4. Crossover Filters
5. PA and Music Systems
6. Audio Amplifiers/Tone and Equalizer Controls
7. Microphones
8. Turntables
9. Tape Machines
10. Tuners

INSTRUCTIONAL PLANNING SHEET

LEVEL VI

CONCEPT

Audio Systems - Sound and Acoustical Fundamentals

DEPTH OF INSTRUCTION

4

LEARNING ACTIVITIES

Introduce, demonstrate and define the BASIC MEASUREMENT of sound.

- Intensity db
- Pitch frequency
- Speed
- Wave length
- Resonance
- Noise
- etc.

Observe how sound is reflected and absorbed.

Determine how acoustics are affected by structures.

Be able to determine what safe levels of sound are.

CONCEPT

Audio Systems - Speakers and Enclosures

DEPTH OF INSTRUCTION

4

## LEARNING ACTIVITIES

Introduce the basic types of speaker enclosures and these characteristics:

1. Horn
2. Bass reflex
3. Infinite
4. Air suspension

Demonstrate the operation of one or more of the enclosure types.

Design and build a speaker enclosure.

Introduce the operating principles of a standard P.M. speaker.

The student should be able to make meaningful measurements of speaker characteristics using woofer, midrange and tweeter type speakers.

INSTRUCTIONAL PLANNING SHEET

LEVEL VI

CONCEPT

Audio Systems - Monaural and Multichannel Systems

DEPTH OF INSTRUCTION

4

LEARNING ACTIVITIES

Introduce the different perceptions of sound to the human ear (as example):

a. distance
b. echos
c. phase
d. direction
e. etc.

Discover how monaural and stereo speaker systems are designed.

INSTRUCTIONAL PLANNING SHEET

LEVEL VI

CONCEPT

Audio Systems - Crossover filters

DEPTH OF INSTRUCTION

4

LEARNING ACTIVITIES

Establish the need for frequency division in speaker systems.

Introduce filter networks commonly found in speaker crossover systems, including Lo pass and Hi pass types.

Demonstrate 6, 12, and 18 db per active crossover systems.

Design and build an operational crossover system.

INSTRUCTIONAL PLANNING SHEET

LEVEL VI

CONCEPT

Audio Systems - PA and Music Systems

DEPTH OF INSTRUCTION

4

LEARNING ACTIVITIES

Introduce PA systems and music systems.

Set up a PA system so that the student is able to connect and trouble shoot the system.

Set up a music system so that the student is able to connect and trouble shoot the system.

Visit a recording studio or live performance of a music group to observe the operation of the audio system.

INSTRUCTIONAL PLANNING SHEET

LEVEL VI

CONCEPT

Audio Systems - Audio Amplifiers
Tone and Equalizer controls

DEPTH OF INSTRUCTION

4

LEARNING ACTIVITIES

Introduce the different types of audio amplifiers.

Discover how inputs and outputs affect operation.

Be able to make diagnostic measures of amplifier operation.

Be able to connect a graphic equalizer into an audio system and adjust for proper operation.

INSTRUCTIONAL PLANNING SHEET

LEVEL VI

CONCEPT

Audio Systems - Microphones

DEPTH OF INSTRUCTION

4

LEARNING ACTIVITIES

Introduce the different types of microphones and explain the operation and characteristic of each.

Be able to place microphones in an audio system properly.

Be able to test and repair microphones.

CONCEPT

Audio Systems - Turntables

DEPTH OF INSTRUCTION

4

LEARNING ACTIVITIES

Introduce types of record turntables and changers as to theory of operation.

Be able to trace the electrical motor drive and audio circuits of a record changer.

Be able to adjust the mechanical systems for proper operation.

INSTRUCTIONAL PLANNING SHEET

LEVEL VI

CONCEPT

Audio Systems - Tape Machines

DEPTH OF INSTRUCTION

4

LEARNING ACTIVITIES

Introduce basic magnetic theory as to the operation of the magnetic recording system.

Determine how record and playback amplifiers operate.

The student will be able to adjust a reel to reel tape recorder for proper operation.

Introduce the principles of operation of cartridge type tape players and recorders.

The student will be able to test, replace belts, etc. and adjust a cassette type tape machine.

CONCEPT

Audio Systems - Tuners

DEPTH OF INSTRUCTION

4

LEARNING ACTIVITIES

Introduce how AM/FM stereo tuners are connected into an audio system.

a. Selection of output impedance
b. Testing for receiver sensitivity and selectivity
c. Testing for distortion
d. Antenna selection.

LEVEL VI

## Television Unit

Concept List

1. Introduction to the Black and White TV System
2. Transmitting the TV Signal
3. The Television Video Monitor Operation
4. The Television Receiver

INSTRUCTIONAL PLANNING SHEET

LEVEL VI

CONCEPT

TV: Introduction to the Black and White Television System

DEPTH OF INSTRUCTION

7

LEARNING ACTIVITIES

The Student Will:

1. Analyze the block diagram of a basic transmitting and receiving TV system.
2. Study the needed optical and image theories as applied to the TV system.
3. Analyze the scheme of picture scanning with the operation of vertical and horizontal deflection.
4. Be able to diagram and explain the operation of a TV camera tube.
5. Recognize the need for sync systems.
6. Determine how a closed circuit TV system operates.

INSTRUCTIONAL PLANNING SHEET

LEVEL VI

CONCEPT

TV: Transmitting the TV Signal

DEPTH OF INSTRUCTION

7

LEARNING ACTIVITIES

The Student Will:

1. Study the composite TV signal and identify the following components:
   a. Horizontal sync
   b. Vertical sync
   c. Picture information
   d. Color burst
2. Study band pass and explain how the sound is transmitted along with the composite video information.
3. Be able to explain what a suppressed side band is.

INSTRUCTIONAL PLANNING SHEET

LEVEL VI

CONCEPT

TV: The Television Video Monitor Operation

DEPTH OF INSTRUCTION

7

LEARNING ACTIVITIES

The Student Will:

1. Analyze a block diagram of a TV monitor and explain what each section does.
2. Study the theory of operation of each of the monitor systems listed belos. Be able to take voltage and resistance readings.
   - A. The CRT
     1. vacuum tube operation
     2. controling brightness
     3. how to focus
     4. how to apply video information
   - B. The Horizontal System
     1. oscillator
     2. sync
     3. amplifier
     4. the fly-back, damper, and boost systems
     5. high voltage
     6. regulator
     7. deflection coils
   - C. The Vertical System
     1. oscillator
     2. sync
     3. amplifier
     4. deflection coils
   - D. The Power Supply
     1. voltages
     2. current requirements
     3. isolation for the CRT
3. Do basic troubleshooting and repair of the TV monitor using a scope to trace signal paths.

INSTRUCTIONAL PLANNING SHEET

LEVEL VI

**CONCEPT**

TV: The Television Receiver

(Tuner, Video IF, Detector, Audio, and Power Supply sections)

DEPTH OF INSTRUCTION

7

## LEARNING ACTIVITIES

The Student Will:

1. Study the operation of types of TV antennal.
2. Explain how a TV antenna should be installed.
3. Study the block diagram of a TV receiver section of a TV set and explain what each block does.
4. Study the theory of operation of each section of a TV receiver (listed below) and explain what each block does.
   - A. Tuner
     1. RF amplifier
     2. oscillator
     3. channel selection systems
     4. UHF section
   - B. Video IF amplifier
     1. band pass
     2. gain
     3. signal tracing
   - C. Video Detector
     1. audio seperation
     2. sync seperator
     3. video output
   - D. Audio system
     1. audio amplifier operation
   - E. Power Supply
     1. voltages
     2. current levels
     3. filtering
5. Do basic troubleshooting.
6. Study the section of a color TV receiver by analysis of a block diagram.
7. Study the operation of a colot TV monitor and discover how it differs from a black and white model.
8. Do basic set up of a color TV receiver to do the following: a) Height and width adjusting b) Color sync c) Convergence d) Purity

## LEVEL VI

## DIGITAL SYSTEMS AND MICROPROCESSORS

CONCEPT LIST:

1. Basic Number systems and codes
2. Microcomputer basics
3. Computer Arithmetic
4. Basic Programming

INSTRUCTIONAL PLANNING SHEET

LEVEL VI

CONCEPT

Microprocessors: Basic Number Systems and Codes

DEPTH OF INSTRUCTION

6

## LEARNING ACTIVITIES

The Student Will:

1. Review digital numbering systems.
2. Be able to convert a decimal number into its binary, octal, hecidecimal, and BCE equivalent.
3. Be able to convert a binary number into its decimal, cotal, hexadecimal, and BCD equivalent.
4. Be able to convert an octal number into its binary and decimal equivalent.
5. Be able to convert a BCD code into its decimal and binary equivalent.

INSTRUCTIONAL PLANNING SHEET

LEVEL VI

CONCEPT

Microprocessor: Microcomputer Basics

DEPTH OF INSTRUCTION

6

LEARNING ACTIVITIES

The Student Will:

1. Be able to define the terms:
   - microprocessor
   - microcomputer
   - I/O devices
   - I/O port
   - byte
   - MPU
   - ALU
   - RAM
   - fetch
   - execute
   - mnemonics
   - bus

2. Be able to write simple, straight-line programs that can be executed by the microprocessor.

INSTRUCTIONAL PLANNING SHEET

LEVEL VI

CONCEPT

Microprocessor: Computer Arithmetic

DEPTH OF INSTRUCTION

7

LEARNING ACTIVITIES

The Student Will:

1. Be able to add, subtract, multiply and divide binary numbers.
2. Be able to manipulate binary numbers using the AND, OR operations

CONCEPT

Microprocessor: Basic Programming

DEPTH OF INSTRUCTION

6

## LEARNING ACTIVITIES

The Student Will:

1. Be able to explain the differences between: machine language
   assembly language
   interpretive language
   compiler language

2. Be able to define: assembler
   interpreter
   object program
   BASIC
   FORTRAN
   COBOL

3. Be able to write programs that can: multiply by repeated addition
   divide by repeated subtraction
   convert binary to BCD
   convert BCE to binary

## LEVEL VI

## Solid State Devices

Concept List

1. Silicon Controlled Rectifier
2. Unijunction Transistors
3. TRIAC and DIAC
4. Photoconductive Cells
5. Light Emitting Diodes LED
6. 555 Timer

CONCEPT

Solid State Devices - Silicon Controlled Rectifier (SCR)

DEPTH OF INSTRUCTION

6

LEARNING ACTIVITIES

The Student Will:

1. Describe the conditions necessary to turn on or turn off a silicon controlled rectifier.
2. Explain the difference between a silicon controlled rectifier's forward breakover and reverse breakover voltage.
3. Build an SCR circuit discovering the gate and anode characteristics.

CONCEPT

Solid State Devices - Unijunction Transistors

DEPTH OF INSTRUCTION

7

## LEARNING ACTIVITIES

The Student Will:

1. Describe the condition required to turn on a unijunction transistor.
2. Explain how a unijunction transistor exhibits a negative resistance once it is turned on.
3. Build a unijunction circuit showing the timing and output characteristics.
4. Name two applications of the unijunction transistor.

INSTRUCTIONAL PLANNING SHEET

LEVEL VI

CONCEPT

Solid State Devices - TRIAC and DIAC

DEPTH OF INSTRUCTION

6

LEARNING ACTIVITIES

The Student Will:

1. Describe the conditions necessary to turn on and off a TRIAC.
2. Describe the operation of a DIAC.
3. Build a TRIAC-DIAC light dimmer and motor speed control circuit.

INSTRUCTIONAL PLANNING SHEET

LEVEL VI

CONCEPT

Solid State Devices - Photoconductive Cells

DEPTH OF INSTRUCTION

7

LEARNING ACTIVITIES

The Student Will:

1. Determine the wave length of any given light frequency.
2. Build a night light control circuit using a photoresistor cell.
3. Apply photovoltaic cells to a motor control circuit.
4. Demonstrate the sensitivity of a photo-darlington circuit.

INSTRUCTIONAL PLANNING SHEET

LEVEL VI

CONCEPT

Solid State Devices - Light-Emitting Diodes (LED)

DEPTH OF INSTRUCTION

7

LEARNING ACTIVITIES

The Student Will:

1. Describe the function of a light-emitting diode.
2. Draw a cross sectional view of an LED showing the basic construction.
3. Build a circuit to observe the operation of a typical LED that emits a visible red light.
   a. Observe the relationship between the LED's forward current and forward voltage as you observe the LED's brightness.
   b. Observe the reverse bias.

CONCEPT

Solid State Devices - 555 Timer

DEPTH OF INSTRUCTION

7

LEARNING ACTIVITIES

The Student Will:

1. Describe the function of a 555 timer.
2. Build the following 555 circuits to demonstrate:
   a. A monostable or one shot mode
   b. An astable, or oscillator, mode
   c. Time delay mode

## LEVEL VI

### APPLIANCE REPAIR

Concept List:

1. Wire Cords and Connection Systems
2. Heating Elements
3. Thermostats and Switches
4. Motors
5. Mechanical Drive Systems
6. Small Appliance Repair Techniques
7. Major Appliance Repair Techniques - Heating Type
8. Major Appliance Repair - Motor-Hydraulic Type

INSTRUCTIONAL PLANNING SHEET

LEVEL VI

CONCEPT

Appliance Repair: Wire Cords and Connection Systems

DEPTH OF INSTRUCTION

8

LEARNING ACTIVITIES

The Student Will:

1. Measure wire size of solid and stranded conductors.
2. Be able to determine types of insulation used on cords and internal wiring in appliances.
3. Connect stranded wire and solid wire by use of soldering, pressure wire ends, screw terminals, and welding.
4. Test cords for opens and shorts.
5. Make temporary and permanent cord repairs.

CONCEPT

Appliance Repair: Heating Elements

DEPTH OF INSTRUCTION

7

## LEARNING ACTIVITIES

The Student Will:

1. Recognize different types of elements used in small appliances and major appliances.
2. Test elements for opens, shorts, or grounds.
3. Make repairs on heating elements.
4. Measure resistance of heating elements.
5. Recognize 120v and 240v elements.
6. Compute the wattage size of elements.
7. Connect terminals to heating elements.
8. Recognize different types of insulation used with heating elements.

INSTRUCTIONAL PLANNING SHEET

LEVEL VI

CONCEPT

Appliance Repair: Thermostats and Switches

DEPTH OF INSTRUCTION

6

LEARNING ACTIVITIES

The Student Will:

1. Recognize contact types used with:
   a. High power A/C
   b. D/C
2. Review types of switches from Level IV.
3. Recognize switch actions used in snap, slide, and touch switch types, etc.
4. Examine different switches used in electrical appliances.
5. Test switch types.
6. Study the operation of the bimetal strip and explain its operation.
7. Study the operation of bimetals and capillary thermostat.

CONCEPT

Appliance Repair: Motors

DEPTH OF INSTRUCTION

6

LEARNING ACTIVITIES

The Student Will:

1. Review magnetic and motor theories from Levels I - IV.
2. Observe motor action by the use of demonstrators for:
   - universal motors
     - series
     - shunt
     - compound
   - squirrel cage motors
     - 2 pole
     - 4 pole
     - starter systems
   - synchronous type motors
     - shaded pole
3. Operate solenoid activated systems.
4. Practice troubleshooting techniques with motors.
5. Perform service proceedures on motors.

INSTRUCTIONAL PLANNING SHEET

LEVEL VI

CONCEPT

Appliance Repair: Mechanical Drive Systems

DEPTH OF INSTRUCTION

6

LEARNING ACTIVITIES

The Student Will:

1. Operate speed change systems using:
   a. Friction drive wheels
   b. Belts and pulleys
   c. Gear chains
2. Calculate speed change ratios for the above systems.
3. Experiment with clutch and brake systems.
4. Discover working theories of:
   a. Rotational agitator drive gear box for washers
   b. Vertical agitator (Frigidare type washers)
5. Discover the theories of lubrication materials.
6. Apply lubrication to mechanical systems.

INSTRUCTIONAL PLANNING SHEET

LEVEL VI

CONCEPT

Appliance Repair: Small Appliance Repair Techniques

DEPTH OF INSTRUCTION

7

LEARNING ACTIVITIES

The Student Will:

1. Make operational checks on small appliances.

2. Disassemble electrical appliances; test the electrical systems, test the mechanical systems, reassemble and test the complete units. Appliances tested will include:
   a. irons
   b. toasters
   c. coffee makers
   d. electric heating pads & blankets
   e. food processors, mixers, can openers, ...
   f. vacuum cleaners & floor polishers
   g. other units (clocks, massagers, etc.)

3. Order parts from parts houses to repair appliances.

INSTRUCTIONAL PLANNING SHEET

LEVEL VI

CONCEPT

Appliance Repair: Major Appliance Repair Techniques -- Heating Type

DEPTH OF INSTRUCTION

7

LEARNING ACTIVITIES

The Student Will:

1. Make operational checks on the following types of major appliances:
   a. Water heaters
   b. Electric ranges
   c. Clothes dryers
2. Use troubleshooting proceedures to find defective parts.
3. Do selective parts replacement in each of the major heating type appliances by proper disassembly and assembly techniques.

INSTRUCTIONAL PLANNING SHEET

LEVEL VI

CONCEPT

Appliance Repair: Major Appliance Repair --

Motor-Hydraulic Type

DEPTH OF INSTRUCTION

6

LEARNING ACTIVITIES

The Student Will:

1. Do operational checks on the following types of major appliances:
   a. Clothes washers
   b. Dish washers
   c. Refrigerators
2. Follow troubleshooting proceedures to find defective parts.
3. Do selective parts replacements in each of the major appliances listed above by the use of proper disassembly and reassembly techniques.

## Safety Note

The materials in this guide are a collection of projects which have been used in electronics programs for years. Some projects have been published in electronics magazines, and others are examples of products from electronics kit companies. It is unfortunate that so little information is given pertaining to safety with line-operated projects. In a class, onlookers often think is a joke when someone gets a shock. Under some conditions a small shock from small inductors under low power may not be harmful, but coming in contact with the power line must be guarded against. As you know, under certain conditions electrical shock can be lethal. In the school shop the conditions can be controlled, but what about the home? The students that thak their projects home to work on them may not have the same safe conditions in their basement "labs".

Some of the projects contained in this guide are line-operated and, because of this, should be undertaken with special care. ALL LINE-CONNECTED PROJECTS should be tested with the use of an ISOLATION TRANSFORMER and under your DIRECT supervision. BEFORE any line-operated project can be taken home, it must be housed in an enclosure which will protect the circuit and will not present a shock hazard. The student needs instruction for safe practices with this project. The student must RECOGNIZE what a hazardous condition is.

The author believes that there is value in working with line voltages, but the personnel must be qualified. Qualification comes from good instruction and practice. It is your responsibility to give the student not only the skills to work but the skills to stay alive and unharmed.

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## Purpose of "Hands On" Projects

The purpose in using projects as part of the training procedure is outlined in the following set of objectives:

By completing prbjects the students will obtain the following:

1. An exposure to the real electronic components in the product form.
2. An awareness of the "state of the art."
3. The construction of the student's own project.
4. A feeling of control and accomplishment.
5. A direct application of electronic theory and practice.
6. Practice in handling tools and materials.
7. The ability to successfully follow circuit plans and drawings.
8. The ability to fit parts together in a professional manner.
9. The ability to work at a speed that will produce quality products.
10. The ability to work safely with power tools and live electrical circuits.
11. The ability to work individually or on a team project.

The accomplishment ot the above objectives depends on your skill to prepare and organize materials and students.

With the beginning student, it is always best to start with a project that is easy for the student to handle. The first attempt by the student must be a successful experience. For this reason, selection of the first project is of prime importance. You cannot tell the student "Here, go and do this." You must sell the project to the student with the enthusiasm of the best salesman. The student's own experience with the project must verify what you have told him or her about it. The student must feel that the project has worth and that he or she has the ablilty to do it. The feeling of self-worth and accomplishment for the student is of maximum importance. You should have samples of projects, in mint condition and working, for the student to see and try out. Remember that the sample must be a work of art. As the student is working his or her way through the project, always work with him or her in positive terms. NEVER use negative terms. unless you can sense that the student wants to hear it. As an exsmple, say: "This is good work. Do you think that there is any way that the quality could be improved?" Normally the student answers by pointing out what must be done.

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Schuler, Charles A., Electronics, Principles and Applications, California, Pennsylvania: McGraw-Hill Book Company, 1979.

Steinberg, William and Walter B. Ford, Electricity and Electronics Basic (fourth edition), Chicago, Illinois: American Technical Society, 1972.

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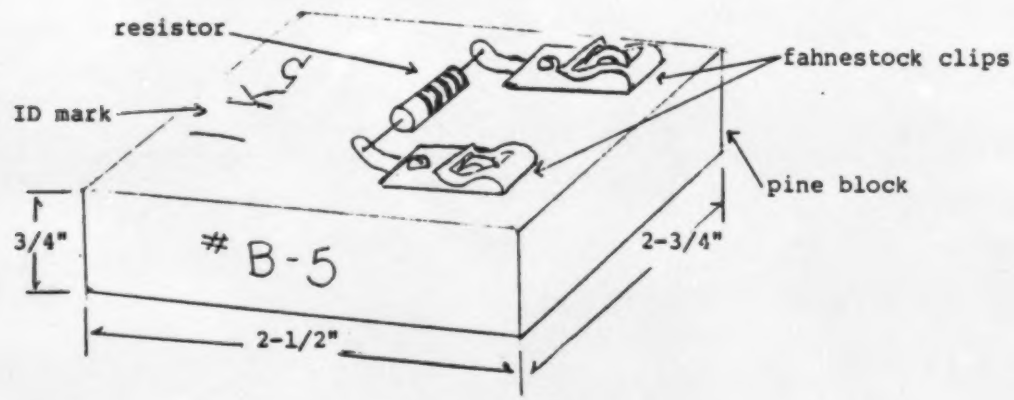
Exploration Sheet Circuit Trainer

for Levels 1-2

A successful experience for the student is a characteristic of a quality teaching system. To provide this type of environment for middle school lab work will require special planning and materials. The Instructional Planning concept sheets and Exploration Sheets provide a well organized study plan and worksheet system for the student. To complete the student's 'hands on' experiences, a circuit trainer should be used for the lab work.

The circuit trainer design as outlined in the following description can be constructed in the shop using standard parts. This will make the units easier to service and also reduce cost. Electronic parts are small and sometimes easy to break. To make them easier to handle they are mounted on 3/4 inch thick pine blocks approximately 2-1/2 inches square (some blocks may have to be larger to accept some components such as power transformers, etc.) The terminals used are medium size fahnestock clips (see below):




Component Block

The connection between the component blocks can be made with hook-up wire to form the circuit.

To make the system easier to move and store, the student should use a tray or board 16 inches to 18 inches square to keep the component blocks on as he or she works.

Minimum Recommended Tool and Equipment List
for Levels I, II, & III

| | |
|---|---|
| soldering iron 30w | 12 |
| replacement tips | 12 |
| pliers, diagonal cutters 5" | 6 |
| pliers, long nose 6" | 6 |
| wrench, vise grip 7" | 2 |
| screwdrivers, #1 phillips | 6 |
| screwdrivers, #2 phillips | 6 |
| screwdrivers, spadebit 3/16" x 8" | 6 |
| nutdriver, 3/16" | 2 |
| nutdriver, 1/4" | 2 |
| nutdriver, 5/16" | 2 |
| nutdriver, 11/32" | 2 |
| nutdriver, 3/8" | 2 |
| aviation snips, M-3 | 3 |
| reamers, 1/8" to 1/2" | 2 |
| reamers, pipe 3/8" to 1-1/2" | 2 |
| pop rivet gun | 2 |
| rivets, .020 to .125 (box) | 2 |
| wire solder 60/40 MC (spool) | 8 |
| wire stripper | 2 |
| hex nuts, 6/32" (box) | 10 |
| machine screws, 6/32" x 1/2" (box) | 10 |
| sheetmetal screws, 3/8" x 4" (box) | 10 |
| sheetmetal screws, 3/8" x 6" (box) | 10 |
| drill bit, 3/64" diameter | 25 |
| drill bit, 3/32" diameter | 5 |
| drill bit, 7/64" | 5 |
| drill bit, 9/64" | 10 |
| drill bit, 1/4" | 5 |
| drill bit, 5/16" | 5 |
| drill bit, 3/8" | 5 |
| solder lugs, 6/32" diameter hole (ea) | 1000 |
| test lead wire, red (feet) | 200 |
| test lead wire, black (feet) | 200 |

| | |
|---|---|
| alligator clips, red (ea) | 100 |
| alligator clips, black (ea) | 100 |
| banana plugs, red (ea) | 100 |
| banana plugs, black (ea) | 100 |
| batteries, 1.5v dry (ea) | 12 |
| bell, electric | 6 |
| buzzer, electric | 6 |
| push button | 6 |
| washers, shakeproof #6 (box) | 10 |
| allen wrench set | 3 |
| headsets, 2000Ω | 6 |
| VTVM meters, electric | 6 |
| audio generators | 3 |
| oscilloscopes | 3 |
| power supplies, 0-20v | 3 |
| enamel wire, #22 (spool) | 1 |

Glossary of Applied Terminology

Concept (electrical) - a series of related applicable theories based on basic electrical laws.

Levels (instructional) - a group of related concepts that are used to make a learning sequence that is keyed to fit the student's ability and knowledge to provide advancement to the next instructional level.

Depth of Instruction - the complexity of instruction that the instructor uses in planning and presenting class activities.

Level sequence - a step-by-step progressive set of courses organized in a simple to complex development to elect5ical skills.

Activities - the class time activities consisting of:

classroom lectures, demonstrations, and assignments in texts and learning materials

laboratory work with experiments and projects

Evaluation - the student's performance will be evaluated by:

written examination

oral examination

work sheets

observation of manipulative skills

operation of test equipment

oral and written explainations of project and experiment function

visual appearance of workmanship

effective participation in class and lab activities

ability to work with others

## WORK EXPERIENCE RECORD

| Dates | Jobs Performed | Evaluation |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |

## PLACEMENT RECORD

| Date | Firm, Address and Contact | Contacted | Interviewed | Result |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |



Student _____

School _____

Instructors _____

Telephone _____

| Program | |
|---|---|
| 1 yr | |
| 2 yr | |
| 3 yr | |

The skill level indicated on this card is a reflection of the student's ability at the time of evaluation. Skill level retention will depend on the amount of time elapsed since evaluation and amount of continued exposure to activities in the stated skill area.

| | The student can accomplish this skill: |
|---|---|
| levels | |
| 9 - 10 | With excellent success at levels equal to, or higher than program standard without supervision. Shows initiative, adaptability and leads others. |
| 7 - 8 | Without supervision, with proficiency in speed and quality. |
| 5 - 6 | Satisfactorily, but requires periodic supervision and or assistance. |
| 3 - 4 | Satisfactorily, but may require repeated orientation. |
| 1 - 2 | With additional training and supervision. |
| NA | No exposure in this area. |

**SAFETY**

| | NA | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| a. Uses equipment properly | | | | | | | | | | | |
| b. Uses safety devices | | | | | | | | | | | |
| c. Uses personal protection | | | | | | | | | | | |
| d. Recognizes hazardous conditions | | | | | | | | | | | |

**TECHNICAL COMMUNICATION**

| | NA | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| a. Reads and follows schematics | | | | | | | | | | | |
| b. Writes service reports | | | | | | | | | | | |
| c. Can look up service data | | | | | | | | | | | |
| d. Has keyboard skills for typing and computer use | | | | | | | | | | | |



ELECTRICITY/ELECTRONICS
VOCATIONAL SKILLS RECORD

(DRAFT)

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APPLIED MATHEMATICS & COMPUTER

| | NA | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| a. Uses basic arithmetic functions | | | | | | | | | | | |
| b. Uses basic algebraic and trigonometric functions | | | | | | | | | | | |
| c. Uses basic computer numbering systems | | | | | | | | | | | |
| d. Uses computer language skills, BASIC | | | | | | | | | | | |
| e. Uses computer language skills, FORTRAN | | | | | | | | | | | |
| f. Uses computer language skills, PASCAL | | | | | | | | | | | |
| g. Uses calculus | | | | | | | | | | | |

MAINTENANCE OF TOOLS AND EQUIPMENT

| | NA | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| a. Identifies and uses basic hand tools | | | | | | | | | | | |
| b. Identifies and uses basic power tools | | | | | | | | | | | |
| c. Maintains hand and power tools for proper operation | | | | | | | | | | | |

TESTING AND TROUBLESHOOTING

| | NA | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| a. Can select correct test equipment | | | | | | | | | | | |
| b. Can do basic circuit analysis | | | | | | | | | | | |
| c. Maintenance of test equipment | | | | | | | | | | | |
| d. Operates test equipment | | | | | | | | | | | |
| e. DC systems - power | | | | | | | | | | | |
| f. AC power distribution systems | | | | | | | | | | | |
| g. Audio systems | | | | | | | | | | | |
| h. RF systems | | | | | | | | | | | |
| i. Digital systems | | | | | | | | | | | |

ASSEMBLY AND REPAIR OF ELECTROMECHANICAL EQUIPMENT

| | NA | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| a. Identifies mechanical and electrical components | | | | | | | | | | | |
| b. Assembles mechanical systems | | | | | | | | | | | |
| c. Assembles electric/electronic systems | | | | | | | | | | | |
| d. Solders and desolders | | | | | | | | | | | |
| e. Connecting and disconnecting assemblies | | | | | | | | | | | |



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BASIC ELECTRIC/ELECTRONIC THEORY

| | NA | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| a. Can apply the basic theories of DC | | | | | | | | | | | |
| b. Can apply the basic theories of AC | | | | | | | | | | | |
| Can describe the basic operation of: | | | | | | | | | | | |
| c. Power supplies | | | | | | | | | | | |
| d. Amplifiers | | | | | | | | | | | |
| e. Oscillators | | | | | | | | | | | |
| f. RF communication circuits | | | | | | | | | | | |
| g. Op amps | | | | | | | | | | | |
| h. Digital fundamentals | | | | | | | | | | | |
| i. Microprocessor applications | | | | | | | | | | | |

HUMAN RELATIONS

| | NA | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| a. Trustworthy | | | | | | | | | | | |
| b. Self-initiative | | | | | | | | | | | |
| c. Self-reliance | | | | | | | | | | | |
| d. Punctuality and attendance | | | | | | | | | | | |
| e. Personal appearance | | | | | | | | | | | |
| f. Leadership and assertiveness | | | | | | | | | | | |
| g. Attitude | | | | | | | | | | | |
| h. Respects the rights of others | | | | | | | | | | | |
| i. Able to work with others | | | | | | | | | | | |

OTHER EXPERIENCE AND COMMENTS